International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 08 | Aug -2017 www.irjet.net p-ISSN: 2395-0072

Sensor Network and Its Power Management using POE

Sharmila B.Babar[1], Prof. Ajit S.Gundale[2]

[1]Student, Electronics Department, Walchand Institute of Technology, Solapur, MH, India
[2]Professor, Electronics, Walchand Institute of Technology, Solapur, MH, India

---

Abstract- Sensor network research has attracted considerable attention but implementation of sensor network is rather costly. Lot of additional wiring may be required to be installed to allow sensors to work - unless the sensors used are wireless .For a wireless sensor node battery life is critical issue. In such conditions the high cost of sensor networks can be reduced and power constraints of WSN can be overcome by implementing sensor network using the Power-over-Ethernet (PoE).Where wired sensor network can be built using already laid Ethernet. By using PoE power management can be done using tight scheduling algorithms under power constraint situation. This paper proposes sensor network using PoE technology and its centralized power management. This system monitors different events using sensors and if event occurs, information is send to controller. Controller will power up corresponding response device. Thus the system is designed as power on demand system. For power management, controller will check for the priority of the event, available power and accordingly power is provided to corresponding response device.

Key Words: Power over Ethernet (PoE), Sensor network, Power management, Wireless sensor network (WSN), Power on demand.

1. INTRODUCTION:

Sensor network research has attracted considerable attention but the general aspects for designing sensor network includes, wide application areas (e.g. structural and health monitoring), the demand for low cost, low-power sensor networks, the ability to record in real time relevant information for the identification of abnormal states, etc. However, the cost of implementation of sensor systems is considerably high, due to the power consumption, wiring, and operation and maintenance aspects. For example, the sensor system of the Tsing Ma Bridge in Hong Kong costs over 8 million [1]. Over 25% of total cost was attributed to installation, like cable arrangements. In addition, over 75% installation time was spent on cable installation [2]. Lot of additional wiring may be required to be installed to allow sensors to work - unless the sensors used are wireless. Using wireless makes sensor devices much more expensive.Power management system is proposed which focuses on centralized power and information management of the sensor network in which nodes are PoE enabled devices.

1.1 Power over Ethernet (PoE):

Power over Ethernet (PoE) is a technique which describes one of the standardized or ad-hoc systems in which electrical power pass along with data on Ethernet cabling. This allows a single cable to provide both data connection and electrical power to devices such as wireless access points or IP cameras. There are other standards such as Universal Serial Bus which also power devices over the data cables, but PoE allows long cable lengths. Power may be carried on the same conductors as the data, or it may be carried on dedicated conductors in the same cable. PoE technology can cut off the man's effort and wiring cost because PoE using LAN cable can deliver power location where power source does not exists, such as the roof, lobby and entrance. So sensor network can be build using PoE technology. Power over Ethernet (PoE) is a technology for hard wired Ethernet LAN's (Local Area Networks) that allows power to flow along cable that would normally be reserved for data signals only. In PoE dc voltage is injected onto the Ethernet cable from a central point which can be a suitable existing network switch or an additional injector. If the end device does not have the inbuilt capability, a splitter is used near the point-of-load to split the power from the data and convert the voltage to what's required by the end device. Where a fully configured network is not used a single channel injector can be used to power just one end device using a single Ethernet cable. The combination of data and power capability over one cable makes product installation easier and potentially safer through avoiding the need for 230 V at the end device. Energy efficiency may also be improved by removing local power adapters but this depends on the relative efficiencies of these compared to the power supply in the injector. Any device that falls within the power limits can use PoE whether it has the inbuilt capability or via a suitable external splitter.

2. Related Work:

Osorio et al [3] proposes a generic sensor network architecture which is developed, combining Power-over-Ethernet (PoE) and Internet of-Things (IoT) concepts. The high cost of sensor networks can be reduced by new technological advances, like the Power-over-Ethernet (PoE) connections, allowing the transmission of both data and electrical power on the same physical Ethernet cable. The interaction between data and power flows leads to advanced power management scenarios, where for instance only a reduced number of reference nodes can be maintained

powered-up ("always-on"), while the rest can be activated as necessary, depending on the data collected on the reference channels.

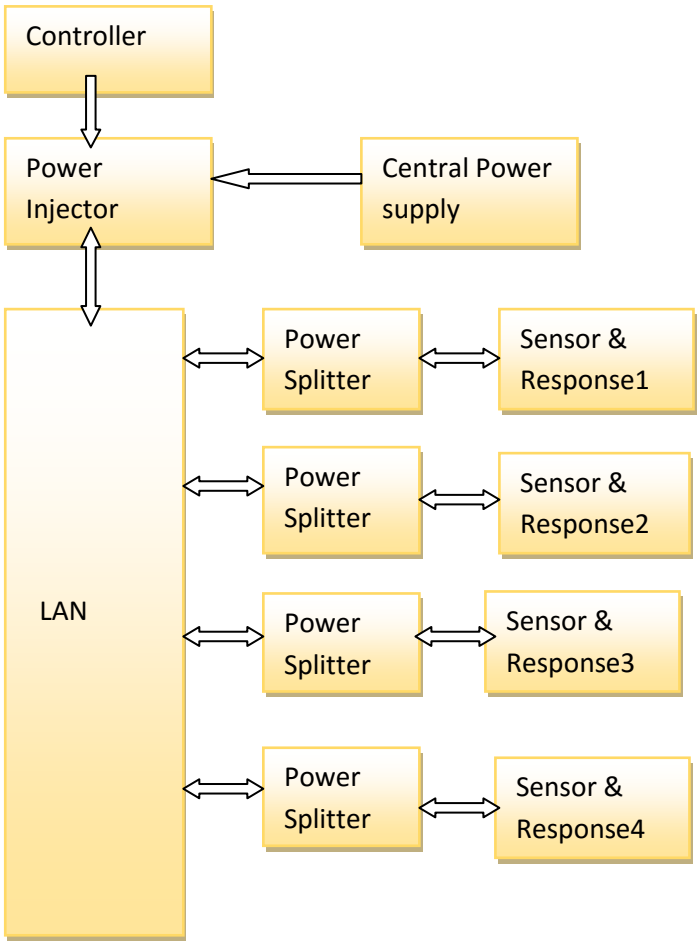
Zhang et al [4] proposes a distributed multichannel data acquisition system based on the IEEE802.3af protocol has been developed to address the need and trend of the data acquisition of the full scale static or fatigue test of the aircraft. The system is powered by the Ethernet network cable, the sensor cable of the system has a smart connector plug which allows the system to identify the sensor cable. The amount of the power cable and the connecting work of sensor cable in the test field can be reduced obviously. This distributed data acquisition system has been used in the full scale static and fatigue test of some sorts of aircraft successfully, the results show that the reliability of distributed data acquisition system has been improved a lot. Yang et al [5] presents a sensor system with proposed algorithm to detect the bridge scour in real time. This work presents rugged sensor system consists of under-water sensor nodes with the wired Power over Ethernet technique. System consists of under-water sensor nodes with the wired Ethernet communication protocol, a PoE switch and a data logger.

Yokohata et al [6] focuses on Power over Ethernet (PoE), which is the technology to carry power on LAN cables, and extend LLDP (Link Layer Discovery Protocol), in which power requests are sent in PoE, so that power is supplied on demand. In on-Demand Power Supply Networks, Powered Devices (PD) are classified by their priority. When a device requires power, it sends a power request message, in which required power and the priority of it is specified, to the network. Then the network decides whether to accept the power request or not. In this paper, we argue on the implementation of on-demand power supply based on PoE, present a lack of features in LLDP, and propose two extensions of it within an approved options of the IEEE standard. The first one is that a PD can send a request PSE (Power Source Equipment) specifying the priority of required power as well as it. The second one is that the PSE can reply back information when a request from a PD is not accepted.

Qiang Gao et al [7] introduces a technology LED intelligent lighting system design and implementation based on PoE of the method. On the basis of analyzing the system architecture, it analyzes the realistic function of the system. This system is an innovative application of PoE technology. It can work in the automatic state according to the information inside the room adjust the lighting intensity automatically.

3. Proposed system:

Proposed system combines the concept of Power over Ethernet (PoE) with sensor network to overcome the installation issues and power constraints. In the Ethernet cable there are 4 pairs of wires data pairs 1–2 and 3–6, spare pairs 4–5 and 7–8. In this system data pairs are used for only carrying data in the LAN whereas spare pairs are used for implementing sensor network. Spare pairs are used for carrying the data of sensor network as well as carrying the power required for sensor network. In the system for instance only sensors can be maintained powered-up ("always-on"), while the actuators and response devices can be activated as necessary, depending on the data collected from the sensors. Controller does this job. So it is power on demand system as this system provides power to response devices only when they needed. Figure 1shows the block diagram of the proposed system.



3.1 Sensors and response devices:

In this work, a sensor network with multiple sensor modules using PoE is designed, and a smart power management scenario is explored. Here pair of sensor and response device forms an application. The module supports both analog and digital sensors. Table 1 lists all the used sensors in this case study, with their output data type and protocols. All these sensors were designed to integrate into the module and preprocessing can be done whenever required. Also priority

is assigned to the applications under power constraint situation.

Table 1: Implemented Sensors with output Protocols

Sensors	Output Type	Protocol
Gas sensor	Analog	SPI (ADC converter)
Motion	Digital	Direct GPIO
Temperature	Analog	SPI (ADC converter)
Light	Analog	SPI (ADC converter)

Table 2: Implemented application with their priority

Application	Priority
Gas sensor and Buzzer	Highest
Motion sensor and dc motor (actuator)	Second
Temperature sensor and Fan	Third
Light sensor and LED bulb	Lowest

3.2 Controller:

Here Raspberry pi is used as controller .The module supports both analog and digital sensors. Controller reads sensor data through gpio pins in case of digital sensors and through ADC interface (SPI interface) when analog sensors are used. When event is occurred like rise in temperature above threshold, motion detection, gas leakage or light intensity below level then controller activates the corresponding response device. Controller also takes care about the battery level so whenever there is fall in battery level then priority scheme is applied to the applications as well as on time of response device is also adjusted to save the power.

3.3 Power Injector:

The POE injector is used to support devices that don't support PoE natively. The POE injector receives data at its one end. It uses a DC power supply and sensor network data as one input. On the other end of the injector, output is a standard Ethernet cable that is capable to transport both data and power.

3.4 Power splitter:

The PoE splitter is used to support end devices that don't support PoE natively (Nodes). The POE splitter receives both data and DC power and sensor network data over the standard Ethernet cable. On the other end of the splitter, it splits into a standard Ethernet cable that is capable to transport data and gives power and data of sensor network to node separately.

4. PoE Power loss:

In PoE applications, there are power losses due to cable resistance. 20 ohms (actually 18.8 ohms) is the maximum loop resistance for 100m Cat5 UTP cabling according to TIA. Typical Cat6 UTP has a 7ohm/100m conductor resistance, resulting in a 7ohm/100m loop resistance.

Table3: Power loss for CAT6 cable

Cable length (meters)	Application	Current (mA)	power loss (mW)
2.7	Gas sensor and Buzzer	154	1.66
2.7	Motion sensor and dc motor (actuator)	250	4.37
2.7	Temperature sensor and Fan	222	3.44
2.7	Light sensor and LED bulb	184	2.36
1.06	Gas sensor and Buzzer	152	1.61
1.06	Motion sensor and dc motor (actuator)	246	4.23
1.06	Temperature sensor and Fan	220	3.38
1.06	Light sensor and LED bulb	182	2.31

Table 4: Power loss for CAT 5 cable

Cable length (meters)	Application	Current (mA)	power loss (mW)
1.2	Gas sensor and Buzzer	152.8	1.66
1.2	Motion sensor and dc motor (actuator)	247	4.37
1.2	Temperature sensor and Fan	220.9	3.44
1.2	Light sensor and LED bulb	183.8	2.36
1	Gas sensor and Buzzer	152	1.61
1	Motion sensor and dc motor (actuator)	246	4.23
1	Temperature sensor and Fan	220	3.38
1	Light sensor and LED bulb	182	2.31

5. CONCLUSIONS

Sensor network can be implemented over Ethernet. Sensor network is built over spare wires of Ethernet cable. One pair of spare wires is used for power while other is used for receiving sensor data and activating response devices. The centralized battery source provide advantage such as power on demand which saves power. Intelligent power management algorithm allows sensor network to utilize battery power efficiently.

ACKNOWLEDGEMENT

I would like to seize the opportunity to express my sincere gratitude towards Head of Department Prof. Mr.S.R.Gengaje, project guide Prof. A.S.Gundale and other electronics department faculties for their invaluable cooperation and guidance.

REFERENCES

1. M. Celebi, 'Celebi, M. "'Draft proposal plan for seismic instrumentation of the cable-stayed Cape Girardeau (MO) Bridge."', Administrative Report - United States Geological Survey, 2001.
2. A. Davidson and C. Hill, 'Measurement of building penetration into medium buildings at 900 and 1500 MHz', IEEE Transactions on Vehicular Technology, vol. 46, no. 1, pp. 161-168, 199
3. Felipe Gabriel Osorio, MA Xinran , Yuan Liu, Paul Lusina , Edmond Cretu "Sensor Networks using Power over Ethernet" computing and communication (IEMCON), 2015 international conference.
4. Yishan Zhang, Jian Li, Huiyu Yang" A Distributed Data Acquisition System With Smart Connector Plugs Powered By The Ethernet Cable" Quality, Reliability, Risk, Maintenance, and Safety Engineering (ICQR2MSE), 2012 International Conference
5. Chih-Chyau Yang, Ssu-Ying Chen, Yi-Jie Hsieh, Fu-Chen Cheng, Yu-Cheng Huang, Jin-Ju Chue, Chih-Ting Kuo, Chien-Ming Wu, Chun-Ming Huang "A Rugged Sensor System for Real-time Bridge Safety Monitoring in Taiwan" 2016 Sensor Application Symposium (SAS)
6. [6] Masaya Yokohata, Tomotaka Maeda, Yasuo Okabe "An Extension of Link Layer Discovery Protocol for On Demand Power Supply Network by PoE" 2013 27th International Conference on Advanced Information Networking and Applications Workshops
7. Qiang Gao, Xiangyu Li, Yuxian Sui, Haiqing Gu, Zhizhong Yu, Qing Zhang, Peng Li "Design and implementation of LED intelligent lighti ng system based on the technology of PoE" The 27th Chinese Control and Decision Conference (2015 CCDC)
8. https://en.wikipedia.org/wiki/Sensor_node.

BIOGRAPHIES

Sharmila Bharat Babar
PG Student, Electronics Department, Walchand Institute of Technology, Solapur.